What is claimed is:

1.   A wireless communications system comprising:

at least four beam formers arranged within a cellular communications network, said beam formers including a first beam former for transmitting a first beam (B1) into a first area and a second beam former for transmitting a second beam (B2) into a second beam area, where said second beam area is adjacent said first beam area, and a third beam former for transmitting a third beam (B3) into a third beam area and a fourth beam former for transmitting a fourth beam (B4) into a fourth beam area, where said fourth beam area is adjacent said third beam area;

a mobile switching center for controlling signals transmitted from said at least four beam formers, including sending coded signals along said beams B1, B2, B3 and B4 such that:

each of said first, second, third and fourth beam areas are effectively divided into at least two sub-areas such that said first beam area includes sub-areas $G1_1$ and $G2_1$, said second beam area includes sub-areas $G1_2$ and $G2_2$, said third beam area includes sub-areas $G1_3$ and $G2_3$, and said fourth beam area includes sub-areas $G1_4$ and $G2_4$; and

wherein during a first time period (T1), simultaneous transmissions are made for receipt by mobile units located within sub-areas $G1_1$, $G1_2$, $G1_3$ and $G1_4$;

during a second time period (T2), transmissions are made for receipt by mobile units located within sub-areas $G2_1$ and $G2_4$; and

during a third time period (T3), transmissions are made for receipt by mobile units located within sub-areas $G2_2$ and $G2_3$.

1   2.   The wireless communications system according to Claim 1, wherein

2 said sub-areas $G1_1$, $G1_2$, $G1_3$ and $G1_4$ are areas with little or no interference from adjacent

3 beams and said sub-areas $G2_1$, $G2_2$, $G2_3$ and $G2_4$ are areas with greater interference from

4 adjacent beams.

1   3.   The wireless communications system according to Claim 1, wherein:

2   said sub-area $G1_1$ begins near an apex of said first area and extends

3 generally down a center of said first area, and said sub-area $G2_1$ is located outside of said

4 sub-area $G1_1$; and

5   said sub-area $G1_2$ begins near an apex of said second area and extends

6 generally down a center of said second area, and said sub-area $G2_2$ is located outside of

7 said sub-area $G1_2$.

1   4.   The wireless communications system according to Claim 1 wherein

2 said first and second areas are divided into sub-areas $G1_1$, $G2_1$, $G1_2$, and $G2_2$ based upon

3 the carrier-to-interference ratio (C/I) of signals being received within each sub-area.

1   5.   A wireless communications system comprising:

2   at least four beam formers arranged within a cellular communications

3 network, said beam formers including a first beam former for transmitting a first beam

4 (B1) into a first area and a second beam former for transmitting a second beam (B2) into

5 a second beam area, where said second beam area is adjacent said first beam area, and a

6 third beam former for transmitting a third beam (B3) into a third beam area and a fourth

7 beam former for transmitting a fourth beam (B4) into a fourth beam area, where said

8 fourth beam area is adjacent said third beam area;

9 a mobile switching center for controlling signals transmitted from said at

10 least four beam formers, including sending coded signals along said beams B1, B2, B3

11 and B4 such that:

12 each of said first, second, third and fourth beam areas are effectively

13 divided into at least two sub-areas such that said first beam area includes sub-areas $G1_1$

14 and $G2_1$, said second beam area includes sub-areas $G1_2$ and $G2_2$, said third beam area

15 includes sub-areas $G1_3$ and $G2_3$, and said fourth beam area includes sub-areas $G1_4$ and

16 $G2_4$; and

17 wherein a group of frequencies are assigned to all of said beam areas

18 within a single cell;

19 further wherein said assigned group of frequencies is divided such

20 that half of said assigned group of frequencies serve mobile units located within sub-areas

21 $G1_1$, $G1_2$, $G1_3$ and $G1_4$ and the other half of said assigned group of frequencies serve

22 mobile units located within sub-areas $G2_1$, $G2_2$, $G2_3$ and $G2_4$.

6. The wireless communications system according to Claim 5, wherein:

the group of frequencies assigned to sub-areas $G2_1$, $G2_2$, $G2_3$ and $G2_4$ is

3 again divided in half, with one sub-group of this group being assigned to sub-areas $G2_1$

4 and $G2_4$ and the other sub-group being assigned to sub-areas $G2_2$ and $G2_3$.

1 7. The wireless communications system according to Claim 5,

2 said sub-area $G1_1$ begins near an apex of said first area and extends

3 generally down a center of said first area, and said sub-area $G2_1$ is located outside of said

4 sub-area $G1_1$; and

5 said sub-area $G1_2$ begins near an apex of said second area and extends

6 generally down a center of said second area, and said sub-area $G2_2$ is located outside of

7 said sub-area $G1_2$.

1   8.   A method for reducing interference in a wireless system including

2   at least two beam formers and a plurality of mobile units, the method comprising the steps

3   of:

4   transmitting a first beam (B1) from a first beam former into a first area,

5   defining two sub-areas within said first area as sub-area $G1_1$ and sub-area $G2_1$;

6   transmitting a second beam (B2) from a second beam former into a second

7   area, defining two sub-areas within said second area as sub-area $G1_2$ and sub-area $G2_2$;

8   coding signals of said beams B1 and B2 for receipt by a particular mobile

9   unit based upon whether the particular mobile unit is located within said sub-area $G1_1$,

10   said sub-area $G2_1$, said sub-area $G1_2$ or said sub-area $G2_2$ such that:

11   during a first time period (T1), making simultaneous transmissions

12   from both said first and second beam formers for receipt by mobile units located,

13   respectively, within said sub-area $G1_1$, or within said sub-area $G1_2$;

14   during a second time period (T2), making transmissions from said

15   first beam former for receipt by mobile units located within said sub-area $G2_1$; and

16   during a third time period (T3), making transmissions from said

17   second beam former for receipt by mobile units located within said sub-area $G2_2$.

1   9.   The method according to Claim 8, wherein:

2   said first area is adjacent to said second area;

3   said sub-area $G1_1$ begins near an apex of said first area and extends

4   generally down a center of said first area, and said sub-area $G2_1$ is located outside of said

5   sub-area $G1_1$; and

6   said sub-area $G1_2$ begins near an apex of said second area and extends

7   generally down a center of said second area, and said sub-area $G2_2$ is located outside of

8   said sub-area $G1_2$.

1   10.   The method according to Claim 9, wherein said sub-areas $G1_1$ and

2    $G1_2$ are each generally teardrop-shaped.

1   11.   The method according to Claim 8, wherein said first and second

2   areas are divided into said sub-areas $G1_1$, $G2_1$, $G1_2$, and $G2_2$ based upon the carrier-to-

3   interference ratio (C/I) of signals being received within each sub-area.

1   12.   The method according to Claim 8, wherein a mobile unit is assigned

2   to one of said sub-areas $G1_1$, $G2_1$, $G1_2$, and $G2_2$ according to the following process:

3   measuring the carrier-to-interference ratio (C/I) for a mobile unit during a

4   4/4 cycle to define a first rate;

5   measuring the carrier-to-interference ratio (C/I) for a mobile unit during a

6   2/4 cycle to define a second rate; and

7   comparing said first rate to said second rate, and if said second rate is

8   larger than twice said first rate, assigning said mobile unit to said sub-area $G2_1$ for said

9   beam B1, or to said sub-area $G2_2$ for said beam B2, otherwise said mobile unit is assigned

10   to said sub-area $G1_1$ for said beam B1, or to said sub-area $G1_2$ for said beam B2.

1   13.   The method according to Claim 8, further comprising:

2   transmitting a third beam (B3) from a third beam former into a third area,

3   defining two sub-areas within said third area as sub-area $G1_3$ and sub-area $G2_3$;

4   transmitting a fourth beam (B4) from a fourth beam former into a fourth

5   area, defining two sub-areas within said fourth area as sub-area $G1_2$ and sub-area $G2_2$;

6   coding signals of said beams B3 and B4, such that:

7   during said period T1, making simultaneous transmissions from said

8   third and fourth beam formers for receipt by mobile units located, respectively, within

9   said sub-area $G1_3$ or within said sub-area $G1_4$; and

10   during said period T2, making transmissions from said fourth beam
11 former for receipt by mobile units located within sub-area $G2_4$; and
12   during said period T3, making transmissions from said third beam
13 former for receipt by mobile units located within sub-area $G2_3$.

1   14.   The method according to Claim 8, wherein said time period T1 is
2   longer than both said time period T2 and said time period T3.

           15.   The method according to Claim 14, wherein said time period T2 is
approximately equal in duration to said time period T3.

           16.   The method according to Claim 8, wherein said time periods T1, T2
and T3 are determined according to the formula $T1/(T2 + T3) = N1/N2 = X$, where N1
is the number of mobile units assigned to said sub-area $G1_1$ for said beam B1 or to said
sub-area $G1_2$ for said beam B2, N2 is the number of mobile units assigned to said sub-
area $G2_1$ for said beam B1 or to said sub-area $G2_2$ for said beam B2, and X is a
predetermined constant.

1   17.   A method for reducing interference in a wireless system including
2   at least four beam formers and a plurality of mobile units, the method comprising the
3   steps of:
4   transmitting a first beam (B1) from a first beam former into a first area;
5   transmitting a second beam (B2) from a second beam former into a second
6   area;
7   transmitting a third beam (B3) from a third beam former into a third area;
8   transmitting a fourth beam (B4) from a fourth beam former into a fourth
9   area;

10   defining at least two sub-areas within each of said first, second, third and

11   fourth beam areas based upon the degree of overlap with adjacent beam areas, whereby

12   each of said beam areas includes at least one overlapping sub-area and at least one non-

13   overlapping sub-area; and

14   coding signals of said beams B1, B2, B3 and B4 for receipt by a particular

15   mobile unit based upon which of said sub-areas the particular mobile unit is located

16   within.

           18.   The method according to Claim 17, wherein said coding is divided

into at least three sequential time periods such that the method includes the following

additional steps:

           during a first time period (T1), making simultaneous transmissions

from all four of said beam formers for receipt by mobile units located within said non-

overlapping sub-areas;

           during a second time period (T2), making transmissions from said

first and fourth beam formers for receipt by mobile units located within said overlapping

sub-areas within said first and fourth areas; and

10   during a third time period (T3), making transmissions from said

11   second and third beam formers for receipt by mobile units located within said overlapping

12   sub-areas within said second and fourth areas.

1   19.   The method according to Claim 17, further comprising the steps of:

2   defining at least a third sub-area within each of said first, second, third and

3   fourth beam areas based upon the degree of overlap with adjacent beam areas, whereby

4   each of said beam areas includes at least one non-overlapping sub-area and at least two

5   overlapping sub-areas, further defined as a first overlapping sub-area and a second

6   overlapping sub-area;

7   comparing the strength of each beam signal within a particular sub-area to

8   determine whether a particular mobile unit is located within said non-overlapping sub-

9   area, said first overlapping sub-area or said second overlapping sub-area.

1   20.   The method according to Claim 19, further comprising the steps of:

2   determining that a particular mobile unit is located within said non-

3   overlapping sub-area if the strength of all beam signals but one are less than a threshold

4   value Y1;

5   determining that a particular mobile unit is located within said first

6   overlapping sub-area if the difference between signal strengths from adjacent beams is

7   less than a threshold value Y2, and the signal strength of said two adjacent beams

8   combined is greater than a threshold value Y3; and

9   determining that a particular mobile unit is located within said second

10   overlapping sub-area if the difference between signal strengths from adjacent beams is

11   less than said threshold value Y3.

1   21.   The method according to Claim 20, wherein said threshold values

2   Y1, Y2 and Y3 are all different values from each other.

1   22.   The method according to Claim 17, further comprising the steps of:

2   effectively dividing each of said first, second, third and fourth beam

3   areas into at least two sub-areas such that said first beam area includes sub-areas $G1_1$ and

4     $G2_1$, said second beam area includes sub-areas $G1_2$ and $G2_2$, said third beam area includes

5   sub-areas $G1_3$ and $G2_3$, and said fourth beam area includes sub-areas $G1_4$ and $G2_4$; and

6   assigning a group of frequencies to all of said beam areas within a

7   single cell;

8   dividing said assigned group of frequencies such that half of said

9   assigned group of frequencies serve mobile units located within sub-areas $G1_1$, $G1_2$, $G1_3$

10   and $G1_4$, and the other half of said assigned group of frequencies serve mobile units
11   located within sub-areas $G2_1$, $G2_2$, $G2_3$ and $G2_4$.

1   23.   The method according to Claim 17, further comprising the steps of
2   dividing the group of frequencies assigned to sub-areas $G2_1$, $G2_2$, $G2_3$ and $G2_4$ in half
3   again, and assigning one sub-group of this group to sub-areas $G2_1$ and $G2_4$ and assigning
4   the other sub-group to sub-areas $G2_2$ and $G2_3$.

1   24.   A beam forming apparatus for use with a wireless communication
2   system, said beamforming apparatus comprising:
3   means for transmitting a beam into a first area and for defining two sub-
4   areas within said first area as sub-area G1 and sub-area G2;
5   means for coding signals of said beam for receipt by a particular mobile unit
6   based upon whether the particular mobile unit is located within said sub-area G1 or said
7   sub-area G2 such that:
8   during a first time period (T1), making transmissions from said beam
9   former for receipt by mobile units located within said sub-area G1, and
10   during a second time period (T2), making transmissions from said
11   first beam former for receipt by mobile units located within said sub-area G2.

1   25.   The beam forming apparatus according to Claim 24, wherein a
2   mobile unit is assigned to one of said sub-areas G1 or G2 by:
3   measuring the carrier-to-interference ratio (C/I) for a mobile unit during a
4   4/4 cycle to define a first rate;
5   measuring the carrier-to-interference ratio (C/I) for a mobile unit during a
6   2/4 cycle to define a second rate; and

7   comparing said first rate to said second rate, and if said second rate is

8   larger than twice said first rate, assigning said mobile unit to said sub-area G2, otherwise

9   said mobile unit is assigned to said sub-area G1.

1   26.   A system of signals for use in a wireless communications system

2   including at least a first beam former and a second beam former and a plurality of mobile

3   units, the signals comprising:

4   signals transmitted from the first beam former into a first area, where said

5   first area is divided into at least two sub-areas defined as sub-area $G1_1$ and sub-area $G2_1$;

6   signals transmitted from the second beam former into a second area, where

7   said second area is divided into at least two sub-areas defined as sub-area $G1_2$ and sub-

8   area $G2_2$;

9   coding said signals from said first and second beam formers for receipt by

10   a particular mobile unit based upon whether the particular mobile unit is located within

11   said sub-area $G1_1$, said sub-area $G2_1$, said sub-area $G1_2$ or said sub-area $G2_2$, such that:

12   signals transmitted during a first time period (T1) are transmitted

13   simultaneously from both said first and second beam formers for receipt by mobile units

14   located, respectively, within said sub-area $G1_1$, or within said sub-area $G1_2$;

15   signals transmitted during a second time period (T2) are transmitted

16   from said first beam former for receipt by mobile units located within said sub-area $G2_1$;

17   and

18   signals transmitted during a third time period (T3) are transmitted

19   from said second beam former for receipt by mobile units located within said sub-area

20      $G2_2$.

1   27.   The system of signals according to Claim 26, wherein:

2   said first area is adjacent to said second area;

3   said sub-area $G1_1$ begins near an apex of said first area and extends

4   generally down a center of said first area, and said sub-area $G2_1$ is located outside of said

5   sub-area $G1_1$; and

6   said sub-area $G1_2$ begins near an apex of said second area and extends

7   generally down a center of said second area, and said sub-area $G2_2$ is located outside of

8   said sub-area $G1_2$.